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1 *"Smart casting" with embedded sensor for condition monitoring.*
2 *Autonomous driving. (Image: © metamorworks / stock.adobe.com)*

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# DIGITALIZED CASTINGS FOR INDUSTRY 4.0 AND AUTONOMOUS DRIVING

**Embedded sensors enable condition monitoring and new concepts in lightweight construction**

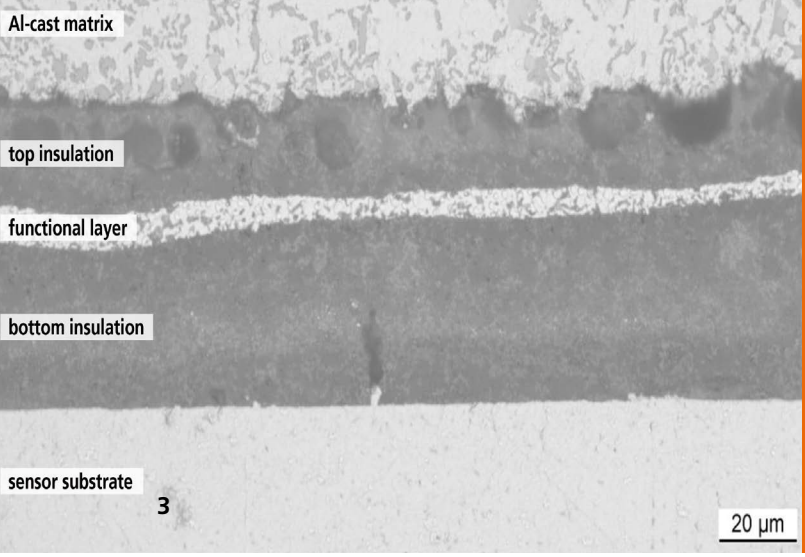
The *CAST*TRONICS® technology enables the embedding of sensors during casting for the measurement of elongation in the component. The aims include condition monitoring as well as new lightweight construction concepts for aluminum castings.

**Digitalization of castings**

The casting technological integration of electronic functional elements allows components with a higher functionality than before, so-called "smart castings". They form the basis for the digitalization of the manufacturing process of castings and further offer novel capacities for the condition monitoring of casting during their usage phase. Through the early detection of critical loads, structures cast from aluminum can in future be monitored and dimensioned to suit the application – thus "smart castings" also offer new lightweight construction concepts.

**Detection of misuse loads**

Embedded sensors enable the detection and measurement of mechanical loads in the components, such as compressive and tensile forces, deformation or vibrations. The recording of temperature data within the component is also feasible. Due to the manufacturing integration during the casting process, the sensors can be embedded directly at the location of the maximum load in order to warn of overloading or damage to the component. This is a decisive advantage, particularly for safety-relevant components.

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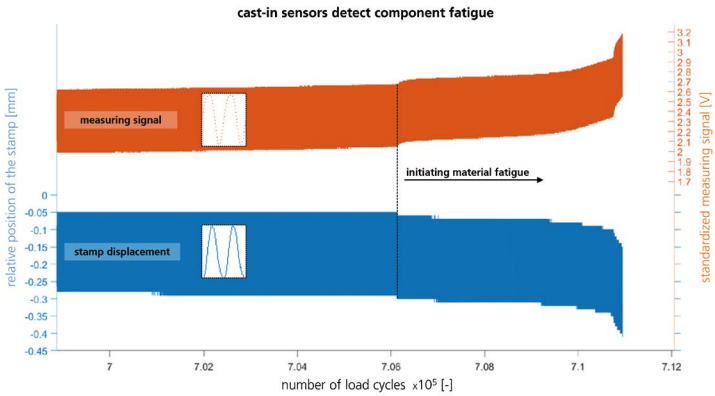


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## Condition monitoring for e-mobility, car-sharing, and autonomous driving

More than any other previous vehicle concept, electromobility requires lightweight construction solutions in order to compensate for the weight of the vehicle's battery. With the ability to monitor the conditions integrated into the components, the previous over-dimensioning of castings can be reduced. Intelligent management can thus actively prevent damage. But electromobility not only brings new vehicle concepts. New business structures such as car-sharing are experiencing an increase. At the same time, the car shifts from being private property to a borrowed possession, and the interest of car-sharing operators is moving to usage behavior and the handling of the cars as well as the loads experienced by the car's components. "Smart castings" offer a series-ready scalable solution for the monitoring and traceability of driving cycles and collective loads.

## Not gluing on, casting in

The aim of the *CAST*$^{TRONICS®}$ technology is the manufacturing technological integration of electronic functional elements directly in the casting process. This enables a subsequent process step to be eliminated. The functional elements are directly integrated into the casting at a suitable position where critical loads are expected and need to be monitored. Thus, in contrast to externally applied strain gauges, the measurement can occur right in the flow of forces. The sensor is protected inside the casting – from loss, from external mechanical damage, and from environmental influences. In addition, a substance-to-substance bond can be considered in cases where a conventional positive-locking bond of the sensor to the casting matrix is not sufficient.

## Sensor function

The sensor function of the thick-film technology works – like conventional strain gauges – via a change in the electrical resistance due to mechanical deformation. Thus both dynamic load changes and static loads can be detected.

## Cooperative research and development

The foundations for the development of castable, resistive, and thermally resistant sensor films based on thick film sensors are being researched in conjunction with the Institute for Microsensors, -Actuators and Systems (IMSAS) at the University of Bremen. This joint effort is investigating various sensor materials with regards to their suitability for casting, analyzing the effects in the casting process, and developing novel designs for sensor structures. At the foundry technology center, the sensors can be embedded using various high and low-pressure casting plants. The finished "smart castings" can subsequently undergo standardized testing in order to analyze the sensor function and component quality.

3 *Embedded sensor in a cross-sectional image.*

4 *Image of a corresponding sensor signal for the punch movement onto the casting in a dynamic fatigue test.*